6.0 CUMULATIVE IMPACT ANALYSIS

The "cumulative impact" of a proposed action under 40 CFR Section 1508.7 of the NEPA regulations is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or persons undertake such other acts." In order to measure cumulative impacts, a point from which measurements begin must be established, called a "baseline." The impact-producing factors of this cumulative effects analysis are baselined to current conditions. That is, the analysis of cumulative effects focuses on the current aggregate effects of all past actions that have taken place within the geographic area without itemizing the historical details of individual past actions. The proposed action is within a non-pristine, but unindustrialized area where current competition for OCS space is not intense. Competition for OCS space in this area is not expected to become intense during the reasonably foreseeable future (20 years) encompassed by this cumulative scenario. No past or present wind energy or other renewable energy projects exist in the geographic area defined for this cumulative analysis.

Geographically, the cumulative impact study area would be described as a polygon generally extending northeastward from Nantucket Island to Monomoy Island including Monomoy Shoals and northwestward from Nantucket Island through Narragansett Bay to Quonset, Rhode Island including Martha's Vineyard. The northernmost boundary would be defined as the northern shore of Nantucket Sound and the easternmost boundary would be a point described as Latitude 41.4571, Longitude -69.8676. This geographic study area includes a broad scope of onshore and offshore projects that have been constructed, or may have the potential to be constructed in the future that could affect the location of the Project (Figure 6.1-1).

Temporally, projects included in the cumulative impact analysis were limited to present activity that includes: (1) the proposed action; (2) any ongoing projects or known proposed projects (i.e., projects for which an application has at least been filed or for which planning documentation exists); and (3) projects not now taking place, but which may occur periodically over the next 20 years because they have occurred in the recent past. Maintenance dredging of channels and harbor areas would be an example of such an activity. In combination, these three classes of activities comprise a cumulative scenario that explains expectations for the kinds of activities that could take place within the study area.

The following agencies were contacted in order to determine what projects were under review or proposed for the near future within the cumulative impact study area: the USACE, New England Division; MassDCR; the CZM; and the MassDEP. The impact levels characterizing cumulative impacts are those used in Section 5.0. Direct impacts occur at the same time and place that the activity occurs. Indirect impacts are displaced in time and space from the factor producing the impact.

6.1 ACTIVITIES IN THE CUMULATIVE SCENARIO

Activities included in the cumulative scenario are as follows:

- Offshore Wind Energy Projects
- Offshore Sand and Gravel Mining
- Tidal Energy Projects
- Marina Development
- Onshore Wind Energy Projects
- Submarine Cable and Pipeline Projects

- Maintenance Dredging and Beach Nourishment
- Upland Pipeline Projects
- Commercial Fishing Activities
- Small Marine Projects
- Vessel Traffic
- Population Growth and Onshore Development
- Wave Energy Projects

6.1.1 Offshore Wind Projects

Currently there is only one other known offshore wind project proposed within the spatial scope of this analysis, for which there is potential for cumulative impacts on environmental resources. This is the South Coast Offshore Wind Project, which is proposed by Patriot Renewables, LLC. The South Coast Offshore Wind Project would be located in the Cape and Islands Ocean Sanctuary of Buzzards Bay (Figure 6.1-1). M.G.L Chapter 132A, Section 15, prohibits among other things, the construction of "electrical generation stations" in an ocean sanctuary. As such, the approval and schedule of the South Coast Offshore Wind Project will depend on if and when the ocean sanctuary legislation can be amended to allow for the construction of wind facilities in an ocean sanctuary.

Patriot Renewables proposes to construct between 90 and 120 WTGs within three general study areas of Buzzards Bay. Study area 1 is an area south of Sconticut Neck and Weset Island and north of Buzzards Bay navigational channel, running from the east edge of the channel to New Bedford Harbor to the east of West Island and terminating at Nasketucket Bay. Study area 2 is located between the Buzzards Bay navigational channel and the Elizabeth Islands, running from Sow and Pigs Reef to Wood's Hole. Study area 3 is located between the mainland of Dartmouth and Westport and the north edge of the Buzzards Bay Navigational channel, running from Hen and Chickens Reef to the west edge of the channel to New Bedford Harbor. The project is expected to produce 300 MW of electricity. Electricity would be transmitted to the mainland electrical transmission system via a submarine cable interconnection to a location in Fairhaven (Patriot Renewables, LLC, 2006). Due to the distance of this project away from the proposed action (approximately 17 miles [27.4 km]) away at its closest point), cumulative impacts are expected to be minor, with the exception of impact to the roseate tern, as discussed in more detail in the Appendix C, where the Patriot Renewables project has the potential to add direct effects to the breeding islands and breeding activities that would not occur with the proposed action.

6.1.2 Offshore Sand and Gravel Mining

In September 2003 Massachusetts entered into a multi-year cooperative agreement with the MMS to locate and assess the quality of sand and gravel resources situated on the continental shelf offshore of Massachusetts. Initial efforts are to document sand and gravel deposits in the inner continental shelf of the Merrimack embayment using geophysical techniques and grab sampling from small vessels. Numerous beaches along the embayment have experienced long-term erosion. Sand and gravel resources on the inner shelf could be found suitable and available for future public works projects to restore beaches or wetlands in this region. The Merrimack embayment is north of Cape Cod and not within the cumulative impact study area, but future characterization activities conceivably could be extended to include the southern inner shelf area of Cape Cod, Martha's Vineyard, and Nantucket Island. For sand and gravel mining in Federal waters beyond 3.5 miles (5.6 km) from shore, a permit from the MMS is needed.

Presently there is one proposal for an offshore sand mining project in the vicinity of Nantucket Sound within state waters. The Sconset Beach Nourishment Project is proposing that approximately 2.6 million cubic yards of beach compatible sediment be hydraulically dredged from a 195 acre (0.78 km^2) borrow site located approximately 2.9 miles 4.6 km) east of Nantucket Island in water that is 30-60 ft deep. The material would then be transported to Sconset Beach on Nantucket and pumped onto the project shoreline from a barge or dredge as a slurry of sand and water. This project would provide beach and dune nourishment for approximately 3.1 miles (4.9 km) of shoreline on eastern Nantucket extending south from Sesachacha Pond, past Sankaty Head Lighthouse to Codfish Park and the Village of Siasconset, and includes dune restoration at Codfish Park and dune construction at the Town Sewer Beds. This sand mining project is in development and environmental review and is contingent upon approval and permitting from several state agencies and the USACE. The sand mining project is anticipated to take place from June to November 2008.

The Town of Barnstable has expressed interest in conducting sand mining projects outside the Cape Cod Ocean Sanctuary boundaries for future beach nourishment. Although there are presently no approvals for sand mining projects, the potential for future activities and associated construction do exist. In the event that two projects occur concurrently in close proximity, there is a potential risk for cumulative impacts associated with the proposed action on environmental and socioeconomic resources, which are discussed in Section 6.3.

6.1.3 Tidal Energy Projects

At present there is only one known proposed TISEC technology development project within the cumulative impact study area[1] Massachusetts Tidal Energy Company (MATidal) proposes to construct one or more clusters of TISEC devices to generate electricity via tidal currents in Vineyard Sound and sell the electricity to the grid. The project is located in navigable waters of the United States in Vineyard Sound in approximately 40 to 75 ft (12.2 to 22.9 m) of water. The underwater area begins at the southeast end of Naushon Island in Vineyard Sound and extends northeast in two separate areas located on either side of Lucas Shoal and Middle Ground, to their terminus at an existing underwater cable crossing that runs between Nobska point in Falmouth and an area west of Lake Tashmoo on Martha's Vineyard. Potential transmission line routes to the shore would intersect an existing underwater cable crossing and would come ashore in Falmouth and/or on the north shore of Tisbury, in Martha's Vineyard (FERC Preliminary Permit Application, 2006).

The project would consist of 50 to 150 TISEC devices, each having the generating capacity of 500 kW to 2 MW (FERC Preliminary Permit Application, 2006). The proponent has stated that the TISEC devices would consist of: (1) rotating propeller blades, approximately 20 to 50 ft (6.1 to 15.2 m) each in diameter; (2) an integrated generator, producing 500 kW to 2 MW of electricity; (3) anchoring systems supporting the TISEC device at varying depths underwater; (4) a mooring umbilical line to an anchor on the sea bottom; and (5) an interconnection transmission line to shore. Monitoring systems for parameters including but not necessarily limited to pressure, temperature, vibration, revolutions per minute, and power output may be located on the TISEC devices and onshore. Transmission from the TISEC device cluster to shore would also be by submerged cable, which may be buried beneath the seabed in its inshore portion. Onshore underground transmission cables would carry the electricity to where it would be fed into the land-based electrical use infrastructure (FERC Preliminary Permit Application, 2006). Potential transmission line routes to the shore would intersect an existing underwater cable crossing and would come ashore in Falmouth and/or on the north shore of Tisbury, in Martha's Vineyard. Information

[1] The Electric Power Research Institute has conducted feasibility studies for tidal projects in the general area, though none of these projects has been proposed by a developer and no permit application filings have been made (TRC, 2006).

regarding the location of on-land interconnects is not provided in the FERC preliminary permit filing (FERC Preliminary Permit Application, 2006).

The schedule indicates that the project would take place in three phases. The first phase would involve testing the devices and would take approximately 20 months to permit, followed by approximately 17 months of testing. The schedule shows that this in turn would be followed by permitting and installation of a partial build-out, followed by permitting and installation of the full build-out. The entire timeline for the project from start to completion of permitting for full build-out is approximately 51 months (FERC Preliminary Permit Application, 2006). This tidal energy project is 10 miles (16.1 km) away from the proposed action at its closest point.

6.1.4 Marina Development

Local marina development was also considered when determining the spatial and temporal scope of the cumulative impact analysis. Whether this activity involves new marina development or maintenance of existing locations, the environmental impacts associated with this activity do exist, but are expected to be relatively small and generally far-field relative to the majority of the proposed action location.

6.1.5 Onshore Wind Energy Projects

The Massachusetts Technology Collaborative's (MTC) Community Wind Collaborative is likely to result in a number of small community initiated wind projects for additional onshore wind power installations. These community based projects are small scale (generally only one or two WTGs) and collectively would fall far short of the producing capacity of the large scale offshore projects such as the proposed action and the South Coast Offshore Wind Project. The environmental impacts associated with the construction, operation, and maintenance of these small land based projects are expected to be localized.

6.1.6 Submarine Cable and Pipeline Projects

Presently, there are three existing submarine cable systems located in Nantucket Sound that connect the mainland with the offshore islands to provide reliable island-wide power supply. There are no known active proposals for new submarine pipelines in the Nantucket Sound area. There are five 25 kV distribution cables that interconnect Martha's Vineyard with Cape Cod, the closest being 13 miles (21 km) to the west of the area of the proposed action. There are two submarine cable systems that connect the mainland transmission system from Harwich and Barnstable (Lewis Bay) to Nantucket Island located approximately 8 miles (13 km) east of the proposed action area. There are no publicly available plans at this time for any future submarine cable system installations in Nantucket Sound or Vineyard Sound except for those associated with the proposed action.

6.1.7 Maintenance Dredging and Beach Nourishment

Another marine construction activity analyzed for cumulative impacts to environmental resources is the maintenance dredging of navigational channels and the disposal of dredged materials for beach nourishment in and around the shores of Nantucket Sound. Maintenance dredging is defined by 301 C.M.R. 11.02 as "any maintenance work or activity carried out on a regular or periodic basis in a manner that has no potential for damage to the environment or for which performance standards have been developed that avoid, minimize, or mitigate potential environmental impacts to the maximum extent possible." Much of the materials used for beach nourishment are from the dredged materials of maintenance dredging activities. The County of Barnstable carries on maintenance dredging in dozens of harbors and inlets for the various waterfront communities around Cape Cod on a rotational basis using the cutterhead DRAGON dredge "*Cod Fish*". Because of the high boat traffic peaking in late June, dredging halts for the summer and does not start again until October. On Martha's Vineyard, the dredge

"*Edgartown*" carries out scheduled maintenance dredging of channels, tidal inlets, and pools. Dredged sand and materials are used for beneficial purposes such as for local beach nourishment.

The submarine cable system for the proposed action would be placed adjacent to the eastern edge of the Federal Navigation Project in Hyannis Harbor. Hyannis Harbor was dredged in 1985, 1991, 1998, and 1999. No future dredging activities are currently scheduled. Nonetheless, if dredging activities were to occur concurrently with the jet-plow installation of the submarine cable system into Lewis Bay, and due to the close proximity of the two activities; they could potentially result in cumulative impacts. Another example is Oak Bluffs Harbor dredging, which is a project consisting of dredging the entrance to Oak Bluffs Harbor with beneficial use of the dredged sand as nourishment on an adjacent town beach. Sediment suspension, deposition, and some mortality of benthos and shellfish in the area of temporary disturbance would need to be considered given concurrent construction activities. Therefore, geology and sediment conditions, benthic and shellfish conditions, and fish resources and commercial/recreational fisheries are discussed in detail in Section 6.3.

6.1.8 Upland Pipeline Projects

This cumulative impact analysis has also taken into consideration the proposed onshore KeySpan Sagamore Line Reinforcement Project with respect to the onshore components of the onshore cable system for the proposed action. KeySpan proposes the construction of approximately 13.1 miles (21.1 km) of a new high-pressure, distribution gas pipeline that is planned to be constructed from the present up until 2013. This reinforcement project is an upgrade to an existing pipeline and the proposed route would be constructed in three segments: Western, Middle, and Eastern. The Western Segment would begin near the intersection of Route 130 and Service Road in Sandwich and extend along Service Road to Route 149 in Barnstable, approximately 5 miles (8 km) from the nearest point along the onshore cable route of the proposed action. The Middle Segment installation runs from KeySpan's South Yarmouth LNG facility on White's Path to the Depot Street and Main Street intersection in Harwich, nearly 2 miles (3.2 km) from the nearest point along the onshore cable route of the proposed action. The Eastern Segment, the farthest segment from the proposed action (approximately 12 miles [19.3 km]), would involve the installation of 1.6 miles (2.6 km) of pipeline from the Depot Road and Route 139 intersection in Harwich to the intersection of Church Street and Route 39 in Harwich. The three segments of the KeySpan Sagamore Line Reinforcement Project do not intersect the proposed onshore cable route and therefore there would be no gas line construction in the vicinity of the proposed action's onshore cable route.

6.1.9 Commercial Fishing Activities

Nantucket Sound experiences a wide range of disturbances on a regular basis in and around the study area. Anthropomorphic disturbances (commercial fishing, anchoring, etc.) repeatedly and regularly affect the environmental resources associated with the water column and the seabed. For example, Churchill (1989) has measured near-bottom TSS to be up to 1,500 mg/L as a result of trawling operations. With the seafloor conditions found in portions of Nantucket Sound, it is possible that upwards of 1.32 yd^3 (1.01 m^3) of suspended sediment could be injected into the water column for every foot of commercial trawling. Commercial fishing is a baseline disturbance factor in Nantucket Sound, resulting in minor temporary disturbances to benthos and brief episodic increases in suspended solids, along with the harvesting of fish, shellfish, mollusks, and shrimp. The WTGs represent a new set of navigation obstacles that would need to be avoided, but they should not measurably alter the ability to undertake commercial fishing within the boundary of the WTGs.

6.1.10 Small Marine Projects

Other marine projects that could be considered in the cumulative impact scenario include the construction of sea walls, docks, piers, shoreline stabilization/erosion control measures, harbor dredging, etc, which collectively are considered as part of the cumulative scenario.

6.1.11 Vessel Traffic

Vessel traffic associated with Nantucket Sound includes ferry services between Cape Cod and the Islands, limited cruise ship traffic, use of the area by commercial fishing vessels, and recreational boating use. The majority of this boating traffic travels along channels setback from the proposed Project (i.e., commercial ferry traffic, cruise ships, large recreational vessels) with boating traffic limited to some recreational boating and commercial fishing in the specific area of the proposed turbine array. Cumulative impacts on vessel traffic are generally expected to be minor due to the limited vessel traffic in the specific area of the proposed action.

6.1.12 Population Growth and Onshore Development

Land-based activities near the ocean may contribute to indirect or associated cumulative impacts on a particular sensitive coastal resource area and may include power plant cooling water intake and discharge facilities, non-point and point source runoff, agricultural activities, storm water run off, and accidental pollutant discharges. Such far-field impacts can have varying degrees of impact on the marine environment in the geographic area of the proposed action depending on the location, extent, and type of activity to the adjacent receiving waters in Nantucket Sound. They are included as a general group of impacts called Population Growth and Onshore Development.

The Massachusetts statewide population over the last century has been continually increasing. Cape Cod and the Islands are no exception. Specifically, Barnstable, Dukes and Nantucket County populations have increased by 19, 29, and 58 percent, respectively between 1990 and 2000. Barnstable County gained 6,453 residents from 2000 to 2004 to reach an estimated total population of 228,683 (a 2.9 percent increase over 4 years), according to the U.S Census. Nantucket County had a 6.3 percent increase and Dukes County increased its total population by 4.6 percent from 2000 to 2004. From 2000 to 2005 the number of housing units in Barnstable County increased by an estimated 6,715 from the U.S Census count of 147,083 in April 2000 to reach 153,798 in 2005. This 4.6 percent housing growth rate (in 5 years) led the state's 12 mainland counties topped only by Nantucket County's 9 percent growth rate up from 9,210 in 2000 to 10,042 in 2004 and Dukes County's 5.6 percent, where homes on Martha's Vineyard and the Elizabeth islands increased from 14,836 in 2000 to 15,670 in 2004 (see Section 4.3.3.1 for further discussion of Cape Cod population trends). This trend of fast-growing population suggests that onshore residential and commercial development would also continue to increase. This increase in onshore development would in turn result in point and non-point source discharges and increased air pollution, which in turn may contribute cumulatively to water and air pollution in the area. The possible contribution of the proposed action to pollution associated with population growth and onshore development is discussed in Section 6.3 as applicable. The alteration of native vegetation, increased human activity on area beaches, and greater recreational boating on the Sound, all have the potential to create cumulative impacts on birds, protected species, aesthetics, noise, wildlife, and air quality.

6.1.13 Wave Energy Projects

Offshore wave energy devices are typically tethered to the seafloor, and could use either suction or gravity anchors. Cables are then connected between the wave energy device and the anchors. As with an offshore wind project, larger wave energy projects would have the devices positioned in an array to take maximum advantage of the prevailing wave direction. Some impacts associated with wave energy devices may include impacts to the benthic environment as a result of anchoring device used, potential for

collision of marine mammals with the devices and or fishery impacts, impacts associated with navigation, and impacts associated with the public use of the waterway.

At present there is a Rhode Island state-funded pilot wave energy project proposed off of Block Island, which is just beyond the southwest edge of the cumulative impact study area. After this is constructed, there are plans for another larger wave energy facility at an unspecified location off of Rhode Island. The developer of the two Projects, Oceanlinx Limited, proposes to first generate 1.5 MW with the pilot project, and then subsequently generate between 15 and 20 MWs as part of the larger project. The wave energy project would use oscillating water technology, whereby waves compress air to drive a turbine. The device includes computers to measure the air pressure and alter the angle of blades in the turbine so that, although the wave action ebbs and flows at different speeds, the turbine spins at a constant rate in a single direction. The wave energy project is anticipated to result in negligible cumulative impacts with the proposed action because it is located far from the area of the proposed action. In addition, the small wave energy associated with the waters of Nantucket Sound relative to other locations makes it unlikely that a wave energy Project would be constructed near the area of the proposed action.

6.2 CUMULATIVE IMPACTS ANALYSIS

The following section discusses impacts of the cumulative scenario and then assesses the extent that the proposed action would incrementally contribute to that impact. The discussion addresses each of the main impact areas discussed in this EIS including: geology and sediment conditions; physical oceanographic conditions; benthic and shellfish resources; fish resources and commercial/recreational fisheries; protected marine species; terrestrial ecology; wildlife and protected species; avian resources; coastal and freshwater resources; water quality; cultural/recreational resources and visual studies; noise; transportation and navigation; electric and magnetic fields; telecommunications; air and climate; and socioeconomics.

6.2.1 Geology and Soft Sediments

Activities that are part of the cumulative scenario that may impact physical oceanographic conditions within the cumulative impacts study area include: (1) sand and gravel mining; (2) undersea pipeline or cable installation; (3) channel maintenance; (4) commercial fishing activities (trawling); and (5) other small marine projects. Direct impacts for all activities have the potential to disturb sediment by contacting the surface, by temporarily suspending sediments, or by temporarily increasing biologic oxygen demand in the water column from suspended organic matter in the sediment.

Impacts to the geology and sediment conditions within Nantucket Sound are likely to occur during construction and decommissioning of the proposed action (i.e., installation and removal of undersea cables and monopiles). Given the dynamic sediment transport and depositional/erosional environments within and surrounding the area of the proposed action, natural processes are anticipated to rapidly restore seabed topography and benthic biology following completion of all construction phases. This would include all proposed phases of construction and operation including pile-driving, jet plow embedment of submarine cable systems, landfall transition interconnections and onshore cabling and conduit installations, including anchoring, winching and spudding activities associated with construction vessels. Mitigation measures, such as scour mats would also be implemented to reduce the impacts to geology and sediments (see Section 9.3). Given the implementation of mitigation techniques used in the construction activities of the proposed action, the impacts would be localized and short-term, and therefore the incremental cumulative impacts to geology and soft sediment conditions as a result of the proposed action are expected to be minor, even if such impacts occur at the same time as activities that are part of the cumulative scenario.

No existing bottom-founded infrastructure exists within the area of the proposed action for which setback could be established, with the exception of the meteorological data tower. If sand borrowing is an activity that takes place on Horseshoe Shoal over the next 20 years, borrow areas would require setbacks from monopiles. Direct impacts from sand dredging that could occur would be equipment that punctures or strikes bottom-founded or buried infrastructure, particularly if locations are poorly known or if pipelines have moved as a result of storm activity. Indirect impacts from sand dredging could be partial exhumation or spanning of pipelines when the slopes at the edges of burrow pits undergo erosion to re-equilibrate with the slope of the surrounding sea floor over time. Pipelines or cables buried in the sediment could have cover reduced or be exhumed if sand dredging takes place too close to infrastructure, making them vulnerable to commercial fishers who bottom trawl, or recreational boaters dropping anchors, for example.

Setback distances from existing infrastructure are needed in the event of dredging or sand mining on Horseshoe Shoal. MMS (USDOI, MMS, 2005) determined that bottom substrates that are sandy need shorter setback distances; on the order of 150 ft (50 m) for borrow pits that are 15 ft (5 m) deep. The time periods needed for burrow pits to either fill or re-equilibrate with the sea bottom are generally on the order of 3 to 6 years for sandy bottom substrates (USDOI, MMS, 2005, p. 161). The high sedimentation rates of mobile sand typically fill disturbed areas or borrow pits relatively quickly making large setback distances from infrastructure unnecessary should sand borrowing occur on Horseshoe Shoal. The area of the sea bottom disturbed by the 130 WTG monopoles and the piles for the ESP totals 0.67 acre (0.003 km^2). Scour protection will cover an additional 2.5 acres (0.1 km^2) if scour mats only are used, or up to 41.8 acres (0.17 km^2) with rock armoring. The sea bottom disturbed by construction or decommissioning vessels, either by direct contact or increased turbidity, is estimated to be 0.25 acre per monopile or 32 acres (0.12 km^2) for 130 monopiles.

The area of sea bottom disturbed by constructing or decommissioning the proposed action is very small in comparison to the available area of sandy bottom on Horseshoe Shoal that would remain undisturbed between the monopiles as well as the area outside the wind park envelope. Bedrock geology below soft sediments will be completely undisturbed by the proposed action and the activities that are part of the cumulative scenario.

Conclusion

Minor long-term impacts to geology and soft sediments as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The total area of permanent benthic impact for the proposed action due to the WTG and ESP piles is 0.67 acres (2,711 m^2) and the total area of temporary impact for the cable that connects the WTGs to the ESP is 580 acres (2.3 km^2). The temporary impact of the area disturbed from installation of the cable from the ESP to the shore is 86 acres (0.3 km^2). The majority of the impacts are temporary and localized and small relative to the size of Nantucket Sound.

6.2.2 Physical Oceanographic Conditions

Activities that are part of the cumulative scenario that may impact physical oceanographic conditions within the cumulative impacts study area include: (1) sand and gravel mining; (2) pipeline projects; (3) submarine cable projects; and (4) the South Coast Offshore Wind Project.

In the unlikely event that a nearby sand and gravel mining project was approved in proximity to the proposed action it would not be expected to have any impact on waves, currents, tides or other physical oceanographic conditions because of the design parameters for the proposed action. The proposed action is not expected to result in changes to existing erosion patterns on the sea bed or on adjacent coastlines or

beaches. Studies have determined that the zone of influence of each WTG pile on current conditions is estimated to be limited to an area of several pile diameters around each WTG (Report No. 4.1.1-4).

Conclusion

Negligible long-term impacts on physical oceanographic conditions are expected as a result of the proposed action or the activities that are part of the cumulative scenario, since none of these potential activities would have anything other than a very small and localized affect on features such as tides, waves, or currents.

6.2.3 Benthic Fauna and Shellfish

Activities that are part of the cumulative scenario that may impact benthic fauna and shellfish include: (1) sand and gravel mining; (2) maintenance dredging; (3) pipeline projects; (4) submarine cable projects; (5) commercial fishing activities; and (6) small marine projects. Direct impacts from all of these activities are limited to the area in which the activity takes place.

If the proposed action was permitted and constructed, sand and gravel extraction within the designated MMS lease area would be precluded, but sand mining could possibly take place near the perimeter of the leased area. In the unlikely event that sand and gravel extraction was approved by MMS over the next 20 years, and took place in proximity to the proposed action, there is the potential for cumulative impacts on the benthic fauna and shellfish resources within the cumulative study area.

Potential impacts to benthic and shellfish resources associated with the construction, operation and maintenance of the proposed action relate directly to that area of the seafloor either displaced by monopiles and scour control systems, or temporarily disturbed during construction and decommissioning. Direct impacts would include crushing or smothering of benthic infauna and epifauna by construction equipment and anchors, monopile foundations, and scour mats. Indirect impacts could be increased turbidity that interferes with filter-feeding organs of benthic invertebrates. These impacts on benthic and shellfish conditions would be localized and short-term.

The applicant has attempted to plan, site, and design the proposed action to avoid and/or minimize impacts to benthic and shellfish resources. In addition, jet-plow embedment for the submarine cable system is minimally intrusive on the seabed and natural conditions are quickly restored after completion of construction due to the predominantly sandy bottom of Nantucket Sound and Lewis Bay (see Section 9 for more mitigation discussion).

The sea bottom area is living space for invertebrates living in, and on, the sediment surface. The degrees of disturbance of benthic area by the proposed action are discussed in 6.3.3. Following disturbance of the sea bottom, the general pattern of succession of marine benthic species begins with initial recolonization by small opportunistic species that reach peak population densities within months of a new habitat becoming available after catastrophic mortality of the previous assemblage. The population density of the initial colonizers declines as adult species migrate into the disturbed area from adjacent undisturbed areas. This transitional period, characterized by a benthic faunal assemblage of higher species diversity and a wide range of functional types may last for years, depending on numerous environmental factors. Provided no new bottom disturbances take place, some members of the transitional assemblage are eliminated by competition, and the benthic species assemblage forms a recovered community comprised of larger, long-lived, and slow growing species that maintain complex biological interactions with one another.

Benthic recolonization and succession have been reviewed to varying extents for a wide variety of habitats throughout the world (e.g., Thistle, 1981; Thayer, 1983; Hall, 1994; Coastline Surveys Limited,

1998; Newell et al., 1998). Re-colonization is highly variable and ranges from within months (e.g., Saloman et al., 1982) to more than 12 years (e.g., Wright, 1977), depending on the habitat type and other physical and biological factors. Focusing on dredging, Coastline Surveys Limited (1998) and Newell et al. (1998) suggested that in general, recovery times of 6 to 8 months are characteristic for many estuarine muds, 2 to 3 years for sand and gravel, and 5 to 10 years as the deposits become coarser.

Once installed and operating, monopile foundations would offer hard substrates in an area that otherwise consists of soft sediments. Each monopile is expected to increase the habitat heterogeneity from what had been only soft bottom communities of invertebrates living in or on the sediment surface to hardground communities having increased abundance of individual species as well as species diversity. The 130 monopiles and rock armor of the proposed action are expected to become encrusted by attached epifauna such as mussels, but could also include barnacles, sponges, bryozoans, and macroalgae, within 5 to 6 years. Abundance and biomass of benthic communities increased 50-150 times at the Danish wind park sites at Horns Rev and Nysed compared with the biomass of native soft bottom communities existing before emplacement of foundation structures (Danish Energy Authority, 2006, p. 44).

Upon decommissioning and removal, what had been a net benefit to benthic community biomass, will be conversely degraded unless artificial reefing of monopiles takes place to some degree.

Conclusion

Minor long-term impacts to the benthic community as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Recolonization of sediment disturbed after the proposed WTG monopile and scour system installation and other bottom-disturbing work that could occur over the next 20 years, such as sand borrowing on Horseshoe Shoal, would occur rapidly. Although the number of individuals, species, and biomass of benthic infauna may approach pre-disturbance levels within 2 to 3 years on sandy substrates, recovery of community composition and trophic structure may take somewhat longer. Undisturbed areas between monopiles and outside of the wind park envelope are sources for faunal in migration and larval recruitment for recolonizing the small areas that are disturbed. The increase in benthic biomass from installation of hard substrate will be degraded in a converse manner after monopiles are decommissioned and removed unless artificial reefing of monopiles takes place to some degree.

6.2.4 Fish Resources and Commercial/Recreational Fisheries

Activities that are part of the cumulative scenario that may impact fish and commercial or recreational fisheries within the cumulative impacts study area include: (1) sand and gravel mining; (2) commercial fishing activities; and (3) maintenance dredging. Direct and indirect impacts are the result of habitat conversion that may improve or degrade existing bottom substrates.

Sand mining would have the potential of disturbing bottom substrates used by shellfish that are commercially fished; however, these disturbances would be limited to the mined area. Construction of the proposed action is not expected to result in measurable direct mortality to adult and juvenile pelagic fish since these life stages are mobile in the water column and are capable of avoiding or moving away from any disturbances associated with construction. Once installed and operating, the presence of the WTGs and ESP may make it more difficult for commercial trawling in the immediate vicinity of each structure. Any adverse impacts to commercial/recreational fisheries would be localized and minor given that commercial fishing activities would still occur in the area of the proposed action. In addition, it is likely that recreational fishing may increase due to the potential for the wind turbine bases to become FADs. As a result, incremental cumulative impacts to fish resources and commercial/recreational fisheries from the Project are expected to be minor.

Once installed and operating monopiles would be hard substrates in an area that otherwise consists of soft sediments. Each monopile is expected to increase the habitat heterogeneity from what had been only soft bottom communities of invertebrates living in, or on, the sediment to hardground communities having increased abundance of individual species as well as species diversity. At the Danish offshore wind parks at Horns Rev in the North Sea and Nysted in the Baltic Sea, the submerged WTG foundations became colonized and encrusted by the common mussel *Mytilus* within 5-6 years after emplacement (Danish Energy Authority, 2006, p. 53). At this latitude and marine setting the mussel is a superior competitor for space compared to other sedentary invertebrate species or algae. Abundance and biomass of benthic communities increased 50-150 times at both Danish wind park sites compared with the biomass of native soft bottom communities existing before emplacement of foundation structures (Danish Energy Authority, 2006, p. 44). Artificial hard substrates are generally considered beneficial to the reproduction and growth of some native mobile species, such as crab, by providing shelter and nursery habitat. At Horns Rev the edible crab *Cancer* colonized the foundation structures as juveniles and adults.

Environmental monitoring studies at Horns Rev and Nysted showed few effects on the fish fauna that could be attributed to the establishment and operation of the wind parks. The use of advanced survey techniques and intensive surveys did not document any clear effects on fish communities. Fish abundance and diversity were not higher inside the wind parks than in the areas outside. At Nysted the effect of the wind park was inferred to be weak because the hard substrate monocultures of mussels encrusted on the foundation elements are only moderately attractive to fish. At Horns Rev investigators performed the fish surveys during the early stages of colonization of the turbine foundations, where a correlation between fish and the wind park may not have been measurable (Danish Energy Authority, 2006, p. 64).

Over the operating lifetime of the wind park, monopiles are expected to cause net increases in biomass on Horseshoe Shoal. In effect these small islands will be enriched ecosystems for duration of the project and are attractants to the invertebrates that live within and among encrusting mussels as well as birds and fish that could favor these associated communities as opposed to mussels alone. The degree of correlation between fish and monopiles in cold water has yet to be firmly established. If monopiles do attract fish they may also be attractants for recreational or commercial fishers.

Upon decommissioning and removal, what had been a net benefit to benthic community biomass, and possibly to fish and birds, will be removed from the setting of Horseshoe Shoal, and these resources will be conversely degraded unless artificial reefing of monopiles takes place to some degree.

Conclusion

Minor long-term impacts on fish and commercial and recreational fisheries as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Environmental monitoring at Danish offshore wind parks to date has been inconclusive as to whether or not wind parks are net attractants for fish. Whether or not monopile foundations would serve as attractants for recreational or commercial fishers is equally inconclusive at this time.

6.2.5 Protected Marine Species

Activities that are part of the cumulative scenario that may impact protected marine species within the cumulative impacts study area include: (1) vessel traffic and vessel strikes associated with marine construction and service vessels; and (2) underwater noise. Direct impact caused by a vessel accidentally striking a marine mammal or turtle could range from lacerations and broken bones to internal injuries and mortality. Direct impacts caused by underwater noise could cause short- to medium-term habitat displacement (i.e., harassment due to decibel level) if marine mammals or sea turtles avoid the wind park

area during construction, as a result of underwater noise. It is likely that only protected species in immediate proximity to pile driving could experience physically harmful sound levels.

Increased vessel traffic could be due to construction and operation of the proposed action or for other marine renewable energy projects (i.e., South Coast Offshore Wind Project or the Cape and Islands Tidal Energy Project), marina development or other marine related work. The proposed action has been sited and designed to avoid, minimize, or mitigate potential impacts to protected marine species. Some mitigation measures include having a NMFS-approved observer on-site during all pile driving activities and using state-of-the-art hydraulic jet plow technology for cable installation and monopile foundations for the WTGs (see Section 9.0 for more mitigation discussion). If marine mammals or sea turtles are present in the area of the proposed action, they are likely to temporarily avoid the area during construction activities. Given the rarity of protected marine species observances in Nantucket Sound and the significant distances between activities within the turbine array and seal haul-out and breeding sites, the potential impacts to these species is further reduced.

During construction of the Danish wind parks at Horns Rev and Nysted, no general change in behavior at sea or on land for marine mammals could be linked to construction activities, such as pile driving. The only effect detected on land was a reduction in the number of seals during pile driving operations at Nysted (Danish Energy Authority, 2006, p. 14). Porpoise abundance were found to slightly decrease during construction at Horns Rev, and at Nysted a clear decrease in abundance was detected in porpoise abundance during construction and operation (Danish Energy Authority, 2006, p. 14).

Conclusion

Minor long-term impacts on protected marine species are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Mitigation is expected to effectively minimize the chance for vessel strikes during support of the proposed action. Increased commercial fishing, recreational fishing, and pleasure boat activity as a consequence of gradually increasing population and economic activity in the area over the next 20 years could result in several unreported or unrealized collisions with protected marine species, primarily turtles or seals, because boaters are not on alert, and therefore unaware of their presence.

6.2.6 Terrestrial Ecology, Wildlife and Protected Species

Activities that are part of the cumulative scenario that may impact terrestrial ecology, wildlife and protected species within the cumulative impacts study area include: (1) onshore sand and gravel mining; (2) beach nourishment; (3) upland pipeline projects; (4) onshore wind energy projects; (5) other offshore wind projects with onshore interconnections; and (6) population growth and onshore development.

Sand and gravel mining and beach nourishment onshore, upland pipeline projects, other offshore wind projects with onshore connections, and onshore wind energy projects have the effect of land conversion to these uses making cumulatively less available land for terrestrial ecosystems, wildlife, and wildlife habitat. Residential and commercial development can cause loss of wildlife habitat due to vegetation clearing. General population growth and increased intensity of land use may pressure wildlife habitat.

The proposed action has been planned, sited, and designed to avoid or minimize impacts to terrestrial ecology, wildlife and protected species and their mapped habitats within the area of the proposed action. For example the proposed onshore route for the cable system is configured to utilize previously developed or disturbed transportation and utility corridors.

Conclusion

Negligible to minor long-term impacts on terrestrial ecology, wildlife and protected species are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The growth of population and economic activity over the next 20 years is expected to place conversion pressure on land now available for terrestrial ecosystems and wildlife.

6.2.7 Avian Resources and Protected Bird Species

Activities that are part of the cumulative scenario that may impact avian resources within the cumulative impacts study area include: (1) sand and gravel mining; (2) other offshore wind projects; (3) onshore wind projects; and (4) onshore development. Direct effects would be restricted to lethal collision hazard to birds or bats posed by operating WTGs. Indirect effects would include the wind park serving as a barrier to movement as a result of the 25 square miles (64.7 km^2) area of the proposed action and temporary disturbance of avian resources in the area during construction and decommissioning activities.

The increase in biomass expected by colonization of the monopile foundations by monocultures of mussels and the invertebrates that live among them could enrich local food sources around monopiles that could attract birds. Environmental monitoring at the Danish wind parks has shown that most of the more numerous bird species showed avoidance responses at both Horns Rev and Nysted (Danish Energy Authority, 2006, p. 15). Birds tended to avoid the vicinity of the turbines and radar tracking has shown that there was considerable movement around the periphery of the wind parks. Post-construction studies showed almost complete absence of divers and scoters within the Horns Rev wind park and significant reductions in long-tailed duck densities within Nysted. Other species showed no significant change or occurred in too few numbers to allow statistical analysis (Danish Energy Authority, 2006, p. 15).

Although the type and extent of impacts to migratory birds are not yet well defined for offshore wind Projects in the United States, some level of bird-strike impacts and mortality associated with the turbine structures from the proposed action and any future offshore projects should be anticipated.

Sand mining could temporarily degrade sea bottom conditions by disturbing the substrate. If birds relied upon elements of the soft bottom fauna for food, they could be displaced from the sand borrow area until re-establishment of the normal community in 2 to 3 years time.

Onshore wind projects in Massachusetts are limited in size and scope due, in part, to a lack of large tracts of available land with adequate wind resources. As a result, all of the proposed onshore projects range from single turbine installations to less than ten WTGs. These projects are proposed in near-shore communities and in towns further inland that have forested hills or ridge tops. The addition of small numbers of widely scattered onshore wind turbines, each of which would have to go through regulatory review to determine appropriate siting and levels of environmental impacts, is not expected to have a significant cumulative effect in combination with the proposed action.

The estuaries, shoals, salt marshes, tidal flats, dunes, and beaches that comprise the Nantucket Sound ecosystem provide important breeding, nesting, and foraging habitat for many species of resident and migratory birds. Nantucket Sound is located along the Atlantic flyway and is recognized as an important migratory stopover area for millions of birds each year. General impacts associated with human activities occur wherever land development happens and where there is a high level of outdoor recreation, such as on Cape Cod and the Islands. Therefore, human activity results in ongoing and continuous impacts at a multitude of locations at very minor individual levels. The total result is that land bird habitat is being altered by residential and commercial development, hundreds of thousands of people visiting coastal beaches, myriads of watercraft (more so in summer months than winter) traversing the ocean and resources being harvested from the ocean. In contrast, the single timeframe to construct and

decommission the project has short-duration effects that would only occur twice. Avian populations are expected to exhibit some avoidance behavior as has been seen at the Danish wind parks. Whether or not birds become habituated to marine WTGs over time is unknown at this time.

One of the avian populations of most concern is the roseate tern, and studies have shown that several areas adjacent to the proposed South Coast Offshore Wind Project in Buzzards Bay (specifically Bird Island and Ram Island) are important breeding areas for endangered roseate terns. Mortality to breeding terns at these locations in Buzzards Bay may have a significant impact on the species. Therefore, although the exact location of the South Coast Offshore Wind Project is unknown, it is reasonable to anticipate that, if constructed, it would have substantially greater impacts than the proposed action on roseate terns. Thus, while the proposed action has the potential for some cumulative impacts, future evaluation and approval of the South Coast Offshore Wind Project would need to undertake the necessary evaluations of potential impacts on the roseate tern. The incremental cumulative impact from the proposed action combined with the South Coast Offshore Wind Project on the roseate tern population could range from minor to at least moderate. Cumulative impacts to the existing predator-prey relationships in Nantucket Sound are expected to be negligible.

Future onshore development would lead to more clearing and, therefore, less avian habitat, but the incremental impacts from the proposed action would be negligible. The greatest threat to birds, in general, continues to be loss or degradation of habitat due to human development and disturbance. For migratory birds requiring multiple areas for wintering, breeding, and stopover points, the effects of habitat loss can be complex (USFWS, 2002). The greatest threats to birds would be collisions with buildings and obstructions such as communication towers and collision or electrocution by high-tension transmission lines (USFWS, 2002). In a coastal and marine setting, bird deaths resulting from domestic and feral cats would be much reduced, and collision hazard with marine vessels and structures accentuated.

Conclusion

Minor long-term impacts on birds as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. The proposed action would result in minor to moderate cumulative impacts on roseate terns. The addition of the potential activities that are part of the cumulative scenario (i.e., the South Coast Offshore Wind Project, refer to Section 6.1.1 for details on this proposed project) has the potential to result in greater cumulative impacts to this species. Existing monitoring devices for bird mortality, such as infra-red detectors, may not uniquely identify an individual species, nor can radar monitoring uniquely identify individual species within a resources area. If individual deaths occur within these populations they may not be able to be conclusively attributed to construction or operation of the proposed action. Monitoring may provide circumstantial evidence, for example, bird carcasses on the water.

6.2.8 Coastal and Freshwater Wetland Resources

Activities that are part of the cumulative scenario that may impact coastal and freshwater wetland resources within the cumulative impacts study area include: (1) sand and gravel mining; (2) pipeline projects; (3) other offshore wind projects; and (4) onshore development. Direct impacts from all of these activities are limited to the area in which the activity takes place.

It is highly unlikely that any sand mining projects would be permitted and approved by Massachusetts inside the state 3.5-mile (5.6 km) limit and Cape and Islands Ocean Sanctuary that would have the potential to affect coastal and freshwater wetland resources. Other offshore wind projects are expected to have similar coastal and freshwater resource impacts (as the proposed action) and implement similar mitigation measures in order to avoid or minimize any coastal or wetland resource impacts. Wetlands have been identified in the vicinity of the area of the proposed action seaward and within the state

territorial limit of Nantucket Sound and Lewis Bay, and along the onshore transmission cable route. The proposed action does not directly impact freshwater wetlands.

Conclusion

Negligible long-term impacts on coastal and freshwater wetlands as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.9 Water Quality

Activities that are part of the cumulative scenario that may impact water quality resources within the cumulative impacts study area include: (1) offshore wind energy projects; (2) sand and gravel mining; (3) tidal or wave energy demonstration projects; (4) small marine projects and marina development; (5) submarine cable and pipeline projects; (6) maintenance dredging and beach nourishment; (7) vessel traffic; and (8) population growth and onshore development. All of these activities have potential for direct impacts that degrade water quality as a result of increased nutrient inputs, biological oxygen demand, and turbidity. These direct impacts occur from multiple and mobile point sources, are spatially disbursed, and range from temporary to semi-permanent.

Oil and grease can enter the water from vessel discharges, deck wash, and bilge discharges. Accidental diesel fuel spills and spills of fluids in the nacelles of the WTGs and spills on the Electrical Service Platform. Increased turbidity and biological oxygen demand can result from dredging or sand mining operations that disturb the bottom and suspend sediment and organic matter. Increased marina activity as well as population growth and onshore development could result in more storm and septic system runoff that may have enriched nutrient contents. Vessel traffic from marine construction projects or pipelines and more fishing or pleasure boats on the water increase the likelihood that deficient, poorly maintained, or out of compliance waste treatment systems could leak untreated human waste or biodegradable materials. The cumulative impact can include: degraded water quality, odors, floating debris, poor underwater visibility, and beach closings from higher bacterial counts on popular beaches.

Potential marine water quality impacts from the proposed action would be limited to sediment disturbance along the cable corridors and at monopile locations from construction vessel anchoring, anchor line sweep, and installation of the scour protection, foundation and cables. Potential impacts to water quality associated with construction and operation of the proposed action and the submarine cable system across Lewis Bay and within Nantucket Sound would be short-term and localized. Further, water quality impacts related to sediment disturbance from installation would be comparable to disturbance already occurring within Nantucket Sound from natural events and fishing gear (see Section 5.3.1.6).

Conclusion

Minor long-term impacts on water quality are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Direct impacts, such as increased turbidity as a result of monopole emplacement or decommissioning and removal are temporary and distributed among 130 monpile sites. The operation of onboard waste treatment systems can help to minimize water quality impacts (for further information on mitigation, refer to Section 9.0).

6.2.10 Visual Impacts

Activities that are part of the cumulative scenario that may affect visual resources within the cumulative impacts study area include: (1) other offshore wind projects; (2) onshore wind projects; (3) increased vessel traffic; and (4) onshore development. Direct impacts result to the presence of offshore infrastructure that can be seen from shore. Direct impacts can be temporary as vessels come and go,

short-term as construction vessels temporarily anchor for monopile construction or removal, and permanent over the operating lifetimes of renewable energy projects located offshore or on land.

Visual alteration to the historic Nantucket Sound setting caused by the WTGs and related structures would affect both historic properties and recreational areas (see Section 5.3.3.4). However, at this time the only other large scale wind farm proposed, the South Coast Offshore Wind Project, would be located in Buzzards Bay more than 17 miles (27.4 km) away and separated from the proposed action area by the Elizabethan Islands. Thus, most areas that have a view of the proposed action would not likely have a view of the South Coast Offshore Wind Project. No information is available at this time about whether the Cape and Islands Tidal Energy Project would require the installation of above water moorings or structures that could cause visual impact. The above discussion also applies to the historic properties analysis discussed in Section 5 in that there are unlikely to be cumulative visual impacts to historic structures from those other projects known to be proposed at this time (i.e., South Coast Offshore Wind Project and Cape and Islands Tidal Energy Project).

Within the cumulative impact study area, no other activity in the cumulative scenario other than the proposed action or onshore wind projects includes activity that has more than a temporary presence on Horseshoe Shoal. Construction or decommissioning vessels will be seen as monopiles are installed or removed and WTGs will be visible from land and on the water over the operating lifetime of the project.

Conclusion

Moderate long-term impacts on scenic quality are expected as a result of the proposed action and the activities that are part of the cumulative scenario. Scenic quality is a highly subjective aesthetic characteristic. Some people believe that WTGs on the water are relatively unobtrusive, while others believe that WTGs represent an unwelcome presence by intruding on a vista with comparatively little man-made infrastructure upon it.

6.2.11 Cultural Resources

Activities that are part of the cumulative scenario that may impact sources of disturbance of cultural resources within the cumulative impacts study area include: (1) sand mining; (2) other offshore wind projects; (3) submarine pipeline or cable projects; (4) onshore wind projects; (5) onshore development; and (6) small marine projects.

Sand mining projects could have physical effects on submerged prehistoric and historic resources that include ground disturbance or destruction. Because sand mining is an extractive process, there exists a possibility that prehistoric and historic resources could be either disturbed or destroyed. It is highly likely, however, that any submerged land approved for sand and gravel mining, as well as for pipeline or submarine cable projects, would be assessed for these resources (i.e., shipwrecks) prior to the start of any mining activities.

Similar to the proposed action, sand and gravel activities would likely be sited and designed to avoid or minimize any adverse impacts to cultural resources. Based on results of the terrestrial archaeological intensive survey, no significant prehistoric or historic archaeological resources have been identified within the Project's APE for ground disturbance along the onshore transmission line route (see Section 5.3.3.5). The proposed action has been sited and designed to avoid disturbance or destruction of submerged prehistoric and historic resources. An archaeological survey has been carried out over the footprint of the proposed action and cable route and has been reviewed by MMS.

Conclusion

Negligible long-term impacts on cultural or archaeological resources are expected as a result of the proposed action and the activities that are part of the cumulative scenario (with the exception of visual impacts on historic properties which will be evaluated pending Section 106 review).

6.2.12 Recreational Resources

Activities that are part of the cumulative scenario that may impact recreational resources, such as beach-centric activity, touring, birding, and recreational fishing, boating or diving, within the cumulative impacts study area include: (1) sand mining; (2) other offshore wind projects; (3) submarine pipeline or cable projects; (4) onshore wind projects; (5) onshore development; and (6) small marine projects.

Increased vessel traffic from these various projects, to the extent they occur concurrently, could cause some marine traffic and temporarily affect recreational boating. Offshore construction of more than one project at once could require temporary access restrictions to recreational boaters of small areas in the immediate vicinity of the construction work. While the proposed action would have visual impacts, they are not expected to affect tourism or the general use and enjoyment of recreational areas including beaches, parks, and use of Nantucket Sound (see Section 4.3.4). The proposed action has been sited and designed to avoid recreational disturbance to the extent possible. Furthermore, sand mining, on and offshore wind, pipeline, and cable projects would also be sited and designed to avoid or minimize potential recreational impacts according to permit requirements of the various applicable regulatory agencies.

Conclusion

Minor long-term impacts on recreational resources are expected as a result of the proposed action and the activities that are part of the cumulative scenario since the proposed action does not preclude any existing recreation and only creates a minor change in the navigation scenario for recreational boaters.

6.2.13 Noise

Activities that are part of the cumulative scenario that may impact above or below-water noise level within the cumulative impacts study area include: (1) vessel traffic; (2) vessel traffic and construction activity for the South Coast Offshore Wind Project, the Cape and Islands Tidal Energy Project; (3) sand and gravel mining; (3) dredging; and (4) other marine construction activity such as beach nourishment, submarine pipeline or cable construction, or small marine projects. Direct impacts would involve hearing damage, annoyance, or change in behavior patterns as a result of noise above or below water.

Direct impacts caused by underwater noise could cause short to medium-term habitat displacement if marine mammals avoid the wind park area during construction, either as a result of underwater noise or otherwise. During construction of the Danish wind parks at Horns Rev and Nysted, no general change in behavior at sea or on land for marine mammals could be linked to construction activities, such as pile driving. The only effect detected on land was a reduction in the number of seals during pile driving operations at Nysted (Danish Energy Authority, 2006, p. 14). Porpoise abundance were found to slightly decrease during construction at Horns Rev, and at Nysted a clear decrease in abundance was detected in porpoise abundance during construction and operation (Danish Energy Authority, 2006, p. 14).

It is expected that similar construction vessel noise from mining and channel maintenance vessels would be comparable to normal vessel traffic existing within Nantucket Sound. Mining equipment noise associated with offshore sand mining projects is likely to have sound levels somewhat less than the pile driving sounds from the construction of the proposed action. The South Coast Offshore Wind Project is expected to have similar noise impacts during construction and decommissioning as the proposed action,

though it is located 17 miles (27.4 km) away and would not likely result in cumulative noise impacts. Operation of the South Coast Offshore Wind Project could also create noise.

The sound impacts of construction of the proposed action would be temporary and are associated with the installation of the monopiles, installation of six smaller diameter piles for the ESP, and vessel traffic for transporting equipment, piles, and workers to and from the site. The jet plow embedment process for laying submarine power cables with a cable barge produces no sound beyond typical vessel traffic in Nantucket Sound. Therefore, the principal sound from construction would be temporary pile driving of the WTG monopiles. There would be no significant underwater sound from the proposed action beyond the general area of the WTG array. Project construction and decommissioning is expected to have minor noise impacts. Operating wind turbines would not be heard from shore, but they would be audible to boaters in proximity to them.

Conclusion

Minor long-term impacts on above- or below-water noise are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.14 Transportation and Navigation

Activities that are part of the cumulative scenario that may impact transportation and navigation within the cumulative impacts study area include: (1) sand and gravel mining; (2) channel maintenance; (3) submarine pipeline or cable projects; (4) other offshore wind projects; (5) commercial fishing activities; and (6) vessel traffic.

For example, impacts associated with sand mining projects would only be short-term and temporary during the time of mining activities. It would be expected that any approved mining activities would not occur in any authorized shipping channels. If projects were constructed at the same time, they could result in minor cumulative impacts on navigation. For example, to the extent the South Coast Offshore Wind Project, the Cape and Islands Tidal Energy Project, sand mining projects and other projects were to occur at the same time, construction vessels may have to share navigational channels. However, such contractors would follow required safe vessel navigational practices and channel widths and water depths in these areas allow for ample room for navigation. There would be minimal temporary impacts to navigation in the immediate vicinity of ongoing construction of the proposed action. Any restrictions that are necessary during construction to protect the safety of mariners would be implemented in coordination with the USCG. Details of the marine-based construction would be closely coordinated with the USCG and local Harbor Pilots.

Conclusion

Minor long-term impacts on airborne or marine transportation or navigation are expected as a result of the proposed action and the activities that are part of the cumulative scenario. WTG lighting and audible proximity warnings provide adequate surface identification of the location of the wind park structures. Adequate lighting of commercial and pleasure vessels are a Coast Guard requirement. The proposed action would not be located in aircraft ascent/decent corridors and its presence would not interfere with military radar.

6.2.15 Electrical and Magnetic Fields

Activities that are part of the cumulative scenario that may impact electrical and magnetic fields within the cumulative impacts study area include: (1) submarine electrical cable installation; and (2) other offshore wind parks requiring electrical cable connections. A direct impact would be demonstrable link between electromagnetic field strength and a detrimental effect on fish or benthic communities. Direct

impacts are limited to behavior changes when in proximity to, or when crossing over, an electromagnetic field from a buried submarine electrical cable that may or may not be correlative with harmful effects or distress.

There are no existing sources of power frequency fields present in the offshore area of the proposed action or underground cables that are proposed near the site other than the proposed action. Electric cables for the South Coast Offshore Project and the Cape and Islands Tidal Energy Project would be 17 and 10 miles (27.4 and 16.1 km) away from the area of the proposed action, respectively, and would not interact with electric or magnetic fields from the proposed action. The addition of the onshore transmission line would not change the existing electric field levels. The new underground transmission line electric fields within the ROW are anticipated to be approximately the same as the existing condition, which is due to the presence of the overhead 115 kV lines. The predominant fields within the existing NSTAR ROW are those generated by the existing overhead lines, whose loading under this interconnection option is not changed by the addition of the proposed action. The predicted impact of adding the underground transmission lines is a negligible change from existing conditions within the ROW and no change in field strength at the ROW edges. The proposed submarine cable system for the transmission line would create no perceptible electric field. Therefore, impacts on humans and marine life from electric and magnetic fields would be negligible. The proposed action would not produce or add to any electric-field exposures in offshore waters or onshore; and any localized affect of magnetic fields is weak and localized to the immediate area around the cables.

The investigation performed at Nysted to detect any effects from the electromagnetic fields on migration and behavior of fish were characterized by a high degree of complexity and many challenges and difficulties in collecting and interpreting the data. The investigations along the cable route show some effects from the cable on fish behavior, but the analysis of these data have only shown a very limited correlation between behaviors and the strength of the electromagnetic field (Danish Energy Authority, 2006, p. 76).

Conclusion

Negligible long-term impacts on electrical and magnetic fields as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario. There may be a demonstrable effect between electromagnetic field strength and fish behavior for certain bottom oriented fish, but such behavior cannot be shown to be detrimental to the individual or living activities.

6.2.16 Telecommunication Systems

Activities that are part of the cumulative scenario that may impact telecommunication systems within the cumulative impacts study area include: (1) other offshore wind parks; and (2) vessel traffic such as effects to sea-borne radio communications on marine vessels, and aircraft communications. A direct impact would be a demonstrable link between the proposed action or other offshore wind parks and interference or degradation of communication signals for existing and necessary means of communications on land, air, or water.

Most telecommunication devices operate on a line-of-sight basis; therefore only large physical obstructions can impede the transmission line-of-sight signals. These large physical obstructions could include multi-story buildings, wind turbines, communication towers, etc. Existing and proposed land based FCC licensed communications towers have been evaluated and were determined not to negatively impact these communication systems. Future projects, such as the South Coast Offshore Energy Project would also be required to obtain FAA approval to ensure they would not interfere with radar communications and to also ensure that they do not interfere with other forms of communications.

Conclusion

Minor long-term impacts on telecommunications systems are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.17 Air and Climate

Activities that are part of the cumulative scenario that may impact air quality or climate within the cumulative impacts study area include: (1) vessel traffic such as commercial and recreational marine vessels emissions, air traffic emissions, personal and commercial vehicle emissions, construction equipment emissions; (2) population growth and onshore development such as power generation, industrial processing; and (3) incremental emissions from the activities of sand and gravel mining, submarine pipeline and cable emplacement, other onshore renewable energy facilities, other offshore wind energy facilities, small marine projects, dredging, beach nourishment, and marina development. Direct impacts constitute the emission of NO_x, SO_x, VOCs, particulate matter, and CO_2. All of the activities in the cumulative scenario produce incremental emission because all activities rely on the combustion of fossil fuels in one form or another. Indirect impacts would include the results of the build-up of air emissions over time, or displacement in time or space for impacts based on these emissions.

The turning of the WTG rotors, which react to the wind rather than create or modify it, would not affect the wind speed and/or wind direction in the waters of Nantucket Sound. Overall, the proposed action by itself would have a minor positive, beneficial effect on air quality by generating electricity for use in New England without producing emissions from the burning of fuel (see Air Benefits Analysis in Section 5.3.1.5.2). The activities associated with the construction, maintenance, and decommissioning would result in some temporary level of emissions over Nantucket Sound due to the fossil fuel fired mobile sources (e.g., material supply vessels, crew boats, cranes and other powered construction equipment). However all of the vessels and equipment would comply with applicable air emission standards.

Conclusion

Minor long-term impacts on air quality and climatic conditions are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.2.18 Socioeconomics

Activities that are part of the cumulative scenario that may impact air quality or climate within the cumulative impacts study area include: (1) sand and gravel mining; (2) other offshore wind projects; (3) onshore wind projects; (4) commercial fishing activities; (5) small marine projects; and (6) onshore development. Direct impacts would be the number of jobs and paychecks attributable to all of the people directly employed who perform these activities. Indirect impacts are the multiplier effects that would result from good and services purchased to support these activities, or the number of jobs attributable to employers that are needed to supply goods and services.

Overall, the proposed action would have a positive socioeconomic effect. During the 27-month construction and installation phase, an estimated 371 full-time positions would result from the proposed action in Massachusetts and Rhode Island. In addition to this employment benefit, IMPLAN input/output economic model predicts secondary induced employment benefit of 206 to 622 jobs in Massachusetts and 388 to 1,150 jobs in Rhode Island. While there may be some minor economic losses should commercial fisherman find they are unable to fish some areas of Horseshoe Shoal during construction, recreational fishing and related spending would likely increase and become an economic benefit. The proposed action's incremental cumulative impact on socioeconomics relative to the other projects mentioned would be minor.

If environmental monitoring shows that monopiles that have been colonized by mussels which then serve to act as fish attracting devices, there would be a small incremental effect on commercial or recreational fishers who direct some of their activity to the areas around monopiles. Monitoring at Horns Rev and Nysted has not convincingly established that fish are attracted to the hard substrate benthic invertebrate community that formed on WTG foundations (Danish Energy Authority, 2006, p. 77).

Conclusion

Minor long-term impacts on socioeconomic resources as a whole are expected as a result of the proposed action and the activities that are part of the cumulative scenario.

6.3 CUMULATIVE IMPACT ASSESSMENT OF ALTERNATIVES

In addition to assessing the potential cumulative impacts of the proposed action relative to other potential activities and developments that might occur in the cumulative study area, a cumulative impact assessment has been undertaken of the alternatives to the proposed action. The following subsections provide cumulative impact discussion of the alternatives that have been studied in detail in this DEIS in a comparative manner with the proposed action.

6.3.1 Monomoy Shoals Alternative

Assessing cumulative impacts of the Monomoy Shoals Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described above in the introduction, encompasses the proposed action and the Monomoy Shoals Alternative. As a result, the location of the Monomoy Shoals Alternative within the study area suggests that the impacts described in Section 6 for the proposed action, would be similar in a geographic and temporal sense as for the Monomoy Shoals Alternative. This assumption is based upon the similarity between the proposed action and the Monomoy Shoals Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Monomoy Shoals Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Chapter 6, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Monomoy Shoals Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. The alternatives analysis at Section 5.4.2.2 shows that the Monomoy Shoals Alternative would have greater environmental impacts than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, essential fish habitat, and T&E species, and have less impact than the proposed action with respect to impacts on visual resources and impacts to cultural resources as they relate to visual impacts on historic structures. These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the Monomoy Shoals Alternative and the proposed action. Another important issue with the Monomoy Shoals Alternative site is that it is located adjacent to the northwestern extent of a designated Northern Right Whale Critical Habitat, and thus within the context of other activities that have the potential to impact whales, such as commercial shipping, there is a greater potential for cumulative environmental impacts to whales than at the area of the proposed action. Another important difference between Monomoy Shoals Alternative and the proposed action is that the Monomoy Shoals Alternative is in close proximity to Monomoy Island, which provides important resting, nesting and feeding habitat for migratory birds, and thus there would be greater potential for cumulative environmental impacts than the proposed action with respect to terrestrial, coastal, and marine birds as well as T&E avian species. With respect to subtidal offshore resources,

cumulative impacts from construction and decommissioning would be greater at the Monomoy Shoals Alternative because of the additional interconnection line length resulting in more acreage of temporary bottom disturbance associated with installation, and the greater wave heights, which would prolong the construction time frame.

6.3.2 South of Tuckernuck Island Alternative

Assessing cumulative impacts of the South of Tuckernuck Island Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described above in the introduction encompasses the proposed action and the South of Tuckernuck Island Alternative. As a result, the location of the South of Tuckernuck Island Alternative within the study area suggests that the impacts described in Section 6 for the proposed action, would be similar in a geographic and temporal sense as for the South of Tuckernuck Island Alternative. This assumption is based upon the similarity between the proposed action and the South of Tuckernuck Island Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the South of Tuckernuck Island Alternative be selected, it is not anticipated that in the aggregate, the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the South of Tuckernuck Island Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.1.2 of the alternative analysis shows that the South of Tuckernuck Island Alternative would have greater impact than the proposed action with respect to avifauna, subtidal resources, non-ESA mammals, fish and fisheries, and essential fish habitat, and less than the proposed action with respect to impacts on visual resources. These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the South of Tuckernuck Island Alternative and the proposed action.

One difference that exists with respect to cumulative impacts is on avifauna. The South of Tuckernuck Island Alternative would have a greater potential for cumulative impacts to terrestrial, coastal, and marine birds than the proposed action, because of the increased area in which the turbines would be located (the South of Tuckernuck Island Alternative would require an area of approximately 36 square miles (93.2 km^2) versus the area of the proposed action, which is 25 square miles (64.7 km^2). The larger area of disturbance increases the potential for avian impacts, and thus to the extent other construction projects affect avian impacts in the area, the South of Tuckernuck Island Alternative would contribute more toward cumulative impacts than the proposed action. Another cumulative impact that would be greater is with respect to subtidal resources as the South of Tuckernuck Island Alternative would be constructed in deeper water and contribute more toward cumulative impacts of benthic habitat (as a result of larger foundation sizes and related alteration of the seafloor) than the proposed action.

6.3.3 Condensed Array Alternative

Assessing cumulative impacts of the Condensed Array Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Condensed Array Alternative. As a result, the location of the Condensed Array Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Condensed Array Alternative. This assumption is based upon the similarity between the proposed action and the Condensed Array Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Condensed Array Alternative be selected, it is not anticipated that in the aggregate,

the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Condensed Array Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.5.2 of the alternative analysis shows that the Condensed Array Alternative would have greater impacts than the proposed action with respect to the competing uses resource category (i.e., commercial and recreational fishing and boating, mining, etc.) during construction, operation, and decommissioning, and less impact during construction for eight resource categories: noise, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, and threatened and endangered species. These differences in environmental impacts are likely to result in the similar corresponding differences in cumulative impacts between the Condensed Array Alternative and the proposed action. One difference that exists with respect to cumulative impacts is that the Condensed Array Alternative would decrease the length of the 33 kV cable needed to connect the WTGs to the ESP from 66.7 miles to 58.0 miles (107.3 km to 93.3 km). This would result in a reduction of temporary impacts during construction and decommissioning to benthic habitats from 580 acres to 504 acres (2.3 to 2.0 km^2). The decrease in length of the 33 kV cable would also decrease temporary impacts to fish and fisheries, and EFH as a result of decreased area of turbidity and disturbed sea bottom. Therefore to the extent other projects occur at the same time or near the same location, the Condensed Array Alternative would contribute less toward cumulative impacts on these resources than the proposed action. Cumulative impacts to T&E species would also be slightly less than for the proposed action as the shorter construction timeframe for the 33 kV cable would result in less disturbance to T&E avian species that could be in the vicinity.

6.3.4 Phased Development Alternative

Assessing cumulative impacts of the Phased Development Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Phased Development Alternative. As a result, the location of the Phased Development Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Phased Development Alternative. This assumption is based upon the similarity between the proposed action and the Phased Development Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Phased Development Alternative be selected, it is not anticipated that in the aggregate the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Phased Development Alternative and the proposed action as described above, there is the potential that some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.4.2 of the alternative analysis shows that the Phase Development Alternative would have greater impact during construction and decommissioning than the proposed action for 10 of 28 resource categories (air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, and recreation and tourism). These differences in environmental impacts are likely to result in similar corresponding differences in cumulative impacts between the Phased Development Alternative and the proposed action. One difference is with respect to cumulative impacts on avifauna. Avifauna impacts would be greater for the Phased Development alternative than for the proposed action because of the longer timeframes of the additional mobilizations and demobilizations of major construction vessels for

pile driving and WTG installation/decommissioning related to each distinct phase. The total number of vessels required to complete the construction and decommissioning would also be greater than required for the proposed action, increasing potential impacts. The longer duration of the phased construction work would result in greater chance of cumulative impacts to avifauna with other ocean related construction projects. For this same reason the longer construction time frame would also increase the chances of additional cumulative impacts to subtidal resources, marine mammals, and fishery resources.

6.3.5 Smaller Project Alternative

Assessing cumulative impacts of the Smaller Project Alternative takes into account all past, present, and reasonably foreseeable future actions that will or may occur in the cumulative impact study area. The cumulative impact study area described in the introduction above encompasses the proposed action and the Smaller Project Alternative. As a result, the location of the Smaller Project Alternative within the study area suggests that the impacts described in Section 6.2 for the proposed action, would be similar in a geographic and temporal sense as for the Smaller Project Alternative. This assumption is based upon the similarity between the proposed action and the Smaller Project Alternative in facility design, construction methodology, service area, installation timing, environmental effects and geographic proximity. Should the Smaller Project Alternative be selected, it is not anticipated that in the aggregate the cumulative effects, as described in Section 6.2, would be significantly different than that for the proposed action.

Although cumulative impacts are generally expected to be similar overall between the Smaller Project Alternative and the proposed action as described above, there are likely some specific cumulative impacts that may differ depending on the particular resource in question. Section 5.4.3.2 shows that the Smaller Project Alternative has less impact than the proposed action in 13 resource categories including: noise, air quality, water quality, avifauna, subtidal offshore resources, non-ESA marine mammals, fish and fisheries, essential fish habitat, threatened and endangered species, visual resources, cultural resources (as they relate to visual impacts on historic structures) competing uses of waters and sea bed, and port facilities. These smaller impacts are likely to result in corresponding smaller cumulative impacts. One notable difference in cumulative impacts would be with respect to benthic impacts, which would be reduced by half (an area roughly proportional to the reduction in the number of WTGs). Thus to the extent other projects are taking place that could result in cumulative impacts, the contribution of impacts from the smaller project toward cumulative impacts would be much less. For this same reason, the difference in benthic disturbance is much smaller and results in a similar reduction in cumulative water quality impacts and cumulative fishery impacts.

6.3.6 No Action Alternative

Assessing cumulative impacts of the No Action Alternative includes analysis of past, present, and reasonably foreseeable future actions that will continue or may occur in the cumulative impact study area of the proposed action. Cumulative impacts associated with adopting this alternative instead of the proposed action would be derived from the absence of an alternative energy source to contribute to the Massachusetts RPS. The extent and degree of impact would be measured by how the loss of energy anticipated by the proposed action would be replaced by other renewable and/or non-renewable sources, and the cumulative impact of those energy sources. The continuation of the development of new non-renewable energy producing facilities would be more likely due to the lack of technology to produce renewable energy other than wind at the scale proposed.

If this energy is replaced by non-renewable sources (fossil fuel), cumulative impacts would be the sum total of the difference between energy facility development in a future that includes the proposed action, and one that does not. That is, the total projected facility development that would occur along with and including the proposed action, compared to the incremental increase of facility development due

to the proposed action not being developed. The Massachusetts Energy Facilities Siting Board has indicated an increasing need for energy in the New England area over the project lifespan of the proposed action. The Independent System Operator, New England 2005 Regional System Plan found that New England needed to supply its own resources to minimize its dependence on neighboring systems throughout the planning period (2009-13). Therefore, it is concluded that this demand will have to be met by the development of some type of energy production facility in the New England area.

The cumulative effect of the No Action Alternative on physical, biological, socioeconomic and human resources would be apportioned to the number and kind of facilities that would be developed to replace the loss of the proposed action's 468 megawatts of electricity. Impacts from new facility operation attributed to no action taken on the proposed project would be an increase of air emissions to those from existing sources that affect air quality; an increased demand for cooling water with the potential to contribute to water quality impacts in surrounding water bodies with associated environmental degradation; plots of land or sea bed upon which facilities are built that are excluded from competing uses, and an expansion in the adverse socioeconomic impact zone from the placement of a variety of fossil fuel (natural gas, oil, coal,) or nuclear facilities at multiple locations that may or may not be in proximity to the cumulative impact study area. An extensive analysis of impacts associated with the No Action Alternative is included in Section 5.4.6.2.